RISE-UP: Ross Ice Shelf and Europa Underwater Probe

Completed Technology Project (2016 - 2020)

Project Introduction

Proposal Goals: On Jupiter's innermost icy moon Europa, the unique combination of an active ice shell and rocky, possibly magmatic interior may give rise to a geochemical system suitable to life [e.g. Hand et al 2009]. To study Europa, we turn to the Earth's ice shelves since the ice-ocean interactions and environmental processes are analogous between the tow environments [e.g. Schmidt et al 2011, Soderlund et al 2013]. Despite permanent darkness under Earth's ice shelves, evidence of life persists. Processes at the ice-ocean interface are hypothesized to provide a substrate and nutrients to ice-borne or –dependent life including raised concentrations of limiting nutrients [Lin et al 2011, Raiswell 2011, Shaw et al 2011]. The issue in further advancing knowledge of under-ice habitability and biological activity both on Earth and Europa is this: we just can't get there! RISE-UP will advance a capable, small form factor Autonomous Underwater Vehicle for long-range exploration under the Ross Ice Shelf in order to develop a vehicle that could, realistically, be flown in the future to Europa or another icy satellite. In this PSTAR project, the RISE-UP team will satisfy the following objectives: Science-We will investigate the ice-ocean system for evidence of its impact on biological activity by 1) addressing how oceanographic conditions such as temperature, pressure, and salinity affect the characteristics of the ice-ocean interface; 2) characterizing the habitability of the ice, ocean and sea floor to determine what properties of and processes within this terrestrial environment are relevant to Europa; and 3) discovering whether the shelf environment is actively supporting organisms and understanding their adaptations. Science Operations-This science is made possible by treating the Ross Ice Shelf, a scientifically compelling target in its own right, as an analog environment and its exploration and analog mission architecture for future astrobiology missions. We will investigate the Ross Ice Shelf where the ice is nearly 0.5km thick, and at the grounding line, where the ice is up to 1 km thick. Technology- We will develop a stable implementation of the Icefin vehicle to 1) deploy through up to 1 km of ice and operate over a 4 km range, at up to 1.5 km depth; 2) use onboard sensors for autonomous navigation; 3) charge itself at a deployable base station at the base of the shelf; 4) detect life in situ using custom microfluidic devices; and 5) sample ice, sediment and water. Proposed Methodology: To characterize under-ice environments and test biological hypotheses, we will use the Georgia Tech hybrid ROV-AUV vehicle Icefin, to search in-situ for biological communities, understand the ice and seafloor, and map ocean water currents; each of these represents transformative observations for climate and planetary science. The vehicle is uniquely instrumented, with a variety of sensors for scientific analysis of the under ice region including sonar sensors for topographic ice mapping, a CTD (current temperature depth) sensor, a Doppler velocity log sensor, and imaging cameras. The autonomy built into Icefin will allow for more efficient data collection of the scientific data. Because the field deployment of AUV and ROV vehicles is complicated both logistically and from a science perspective, it is critical that scientists and engineers for such a project are integrated as

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Organizational Responsibility

Responsible Mission Directorate:

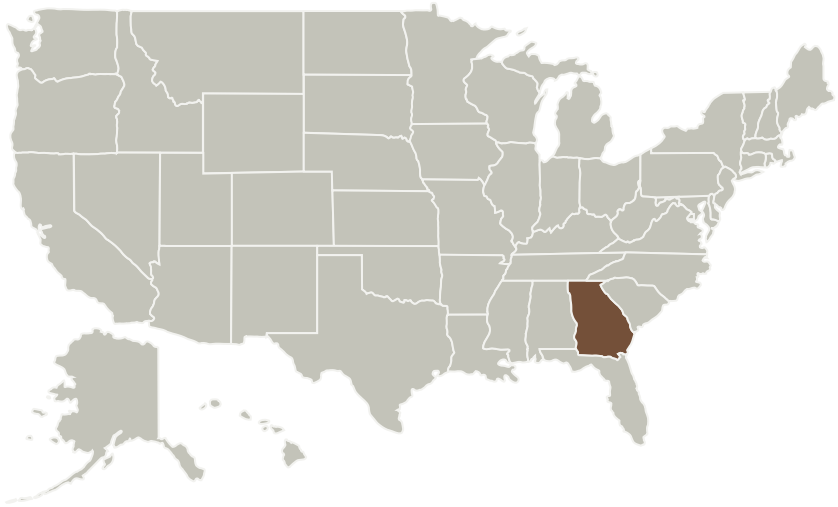
Science Mission Directorate (SMD)

Responsible Program:

Planetary Science and Technology Through Analog Research

proposed here. No other existing system can meet the requirements of the science investigations described in this proposal. Relevance: This project will enhance our understanding of the evolution of Europa's ice shell, a prime target in NASA's search for life beyond Earth and the limits of life here while developing techniques for future exploration of ice-ocean ecosystems. Thus this project is relevant to NASA and to PSTAR program by developing technologies and achieving science relevant to planetary science and exploration in an analog environment.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Georgia Tech Research Corporation	Supporting Organization	Academia	Atlanta, Georgia

Primary U.S. Work Locations
Georgia

Project Management

Program Director:

Carolyn R Mercer

Program Manager:

Sarah K Noble

Principal Investigator:

Britney Schmidt

Co-Investigators:

Jennifer B Glass
Christopher E D'urbano
Amanda Stockton

Technology Areas

Primary:

- TX01 Propulsion Systems
  - TX01.3 Aero Propulsion
    - TX01.3.11 Engine Icing

Target Destination

Others Inside the Solar System